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Rediscovery of *Gastrodia shimizuana* Tuyama (Orchidaceae) on Iriomote Island, Japan

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We recently found two populations of *Gastrodia* (Orchidaceae) similar to *G. shimizuana*, *G. hiemalis* and *G. pubilabiata* on Iriomote Island in the Ryukyu Islands. *Gastrodia shimizuana* is a mycoparasitic orchid collected on Iriomote Island and known only from the type. *Gastrodia pubilabiata* is also a rare species for which no detailed morphological observations have been made. *Gastrodia hiemalis* appears to be closely related to *G. pubilabiata* and is endemic to Taiwan. Morphological variation based on population samples of our unknown *Gastrodia* and *G. pubilabiata* is reported here. The unknown *Gastrodia* can be distinguished from *G. pubilabiata* by the dimensions of the floral parts, the shape of the petals and lip, and floral color. Since our collection differs only in minor features from the original description of *G. shimizuana* we consider it to be that species.

Key words: *Gastrodia hiemalis*, *Gastrodia pubilabiata*, *Gastrodia shimizuana*, Orchidaceae.

The genus *Gastrodia* R. Br. (Orchidaceae) is a mycoparasite in temperate and tropical areas of Asia and neighboring regions. Schlechter (1911) recognized 14 species of *Gastrodia*; 33 species have been described subsequently. One group of *Gastrodia*, represented by *G. verrucosa* Blume (*G. verrucosa* group), has inflorescences of only 3-15 cm in flower but 30-40 cm in fruit with elongated pedicels. Plants of this group are rarely found in flower and therefore have not been studied intensively. Five species of Japanese *Gastrodia* belong to this group: *G. nipponica* (Honda) Tuyama, *G. confusa* Honda et Tuyama, *G. boninensis* Tuyama, *G. pubilabiata* Y. Sawa, and *G. shimizuana* Tuyama.

Gastrodia shimizuana Tuyama (1982) was described from a collection made by D. Shimizu in 1981 on Iriomote Island, the Ryukyu Islands. No further collections have been made since then, although some fruits of *Gastrodia* were observed near the type locality (Hashimoto *et al.* 1991). *Gastrodia shimizuana* has never been thoroughly examined morphologically, nor has it been sufficiently compared with congeneric species.

On February 19 and 23, 2000, we found plants of a species of *Gastrodia* flowering at two localities on Iriomote Island. Our plants generally agreed with the description of *G. shimizuana* (Tuyama 1982), but had a pubescent lip, which thus far has been found only in *G.*

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TABLE 1. Collection localities of specimens examined

Locality1)	Voucher specimens
Unknown *Gastrodia* (rediscovered *G. shimizuana*)	
Okinawa Pref.: northern Iriomote Island (4)	*Kobayashi 3679* (TNS)
Okinawa Pref.: eastern Iriomote Island (1)	*Kobayashi 3678* (TNS)
G. pubilabiata	
Fukuoka Pref.: Tateiwa, Iizuka-shi (14)	*Kobayashi 3909* (TNS), *Kobayashi 3911* (TNS)
Shizuoka Pref.: Yashiroyama, Toyooka-mura (4)	*Kobayashi 3913* (TNS)
Shizuoka Pref.: Hirakuchi, Hamakita-shi (9)	*Kobayashi 3914* (TNS)
Shizuoka Pref.: Sakamoto, Shimada-shi (7)	*Kobayashi 3918* (TNS)
Aichi Pref.: Tame-cho, Toyohashi-shi (3)	*Nagata 20001010* (TNS)

1)Number of flowers sampled in parentheses.

pubilabiata Sawa and *G. hiemalis* T. P. Lin in the *G. verrucosa* group. *Gastrodia pubilabiata* is more widely distributed than *G. shimizuana* (Sawa 1980); there are records from 11 prefectures in Japan (Sugino & Suzuki 1983, 1985; Environment Agency of Japan 2000; Tagawa 2000), but a detailed description of the species is unavailable. *Gastrodia hiemalis* T. P. Lin (1987) appears to be closely related to *G. pubilabiata* and is endemic to Taiwan. We present here detailed descriptions of our plants and *G. pubilabiata* and compare them with the original descriptions of *G. shimizuana* and *G. hiemalis*.

Materials and methods

One flower per inflorescence was collected from two populations of our unknown *Gastrodia* and five populations of *G. pubilabiata* (Table 1) and placed in FAA until they were examined. Some whole plants with flowering or fruiting inflorescences were also collected. Flowering plants were placed in FAA and fruiting plants were preserved as dried specimens. Fixed and dried specimens were examined under a dissecting microscope. The color of the flowers was recorded in the field, and the thickness of the rhizomes was estimated from photos of living plants. Voucher specimens are deposited in the herbarium of the National Science Museum, Tokyo (TNS).

Results

Our unknown *Gastrodia* was readily distinguished from *G. pubilabiata* only by the dimensions of the petals, lip and column (Figs. 1, 2). Populations of neither species showed any conspicuous differences in morphology.

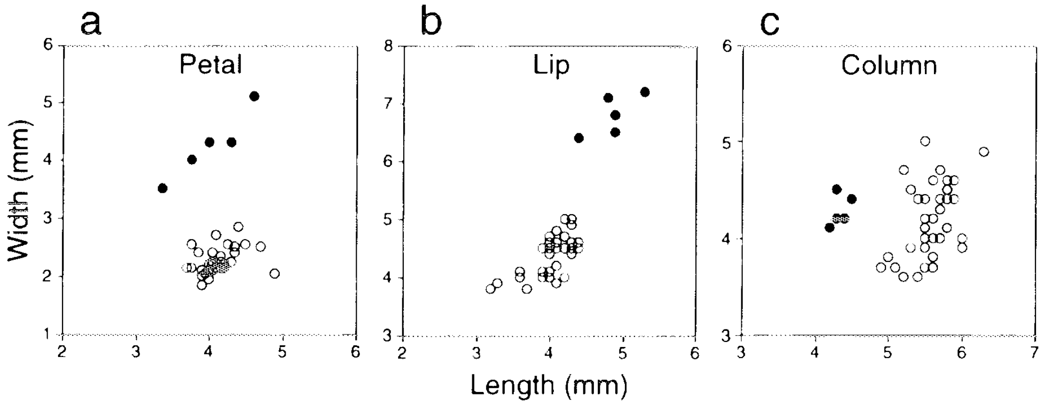

FIG. 1. Dimensions of petal, lip, and column of unknown *Gastrodia* (rediscovered *G. shimizuana*) and *G. pubilabiata*. a: petal. b: lip. c: column. Solid circles: unknown *Gastrodia*. Open circles: *G. pubilabiata*.

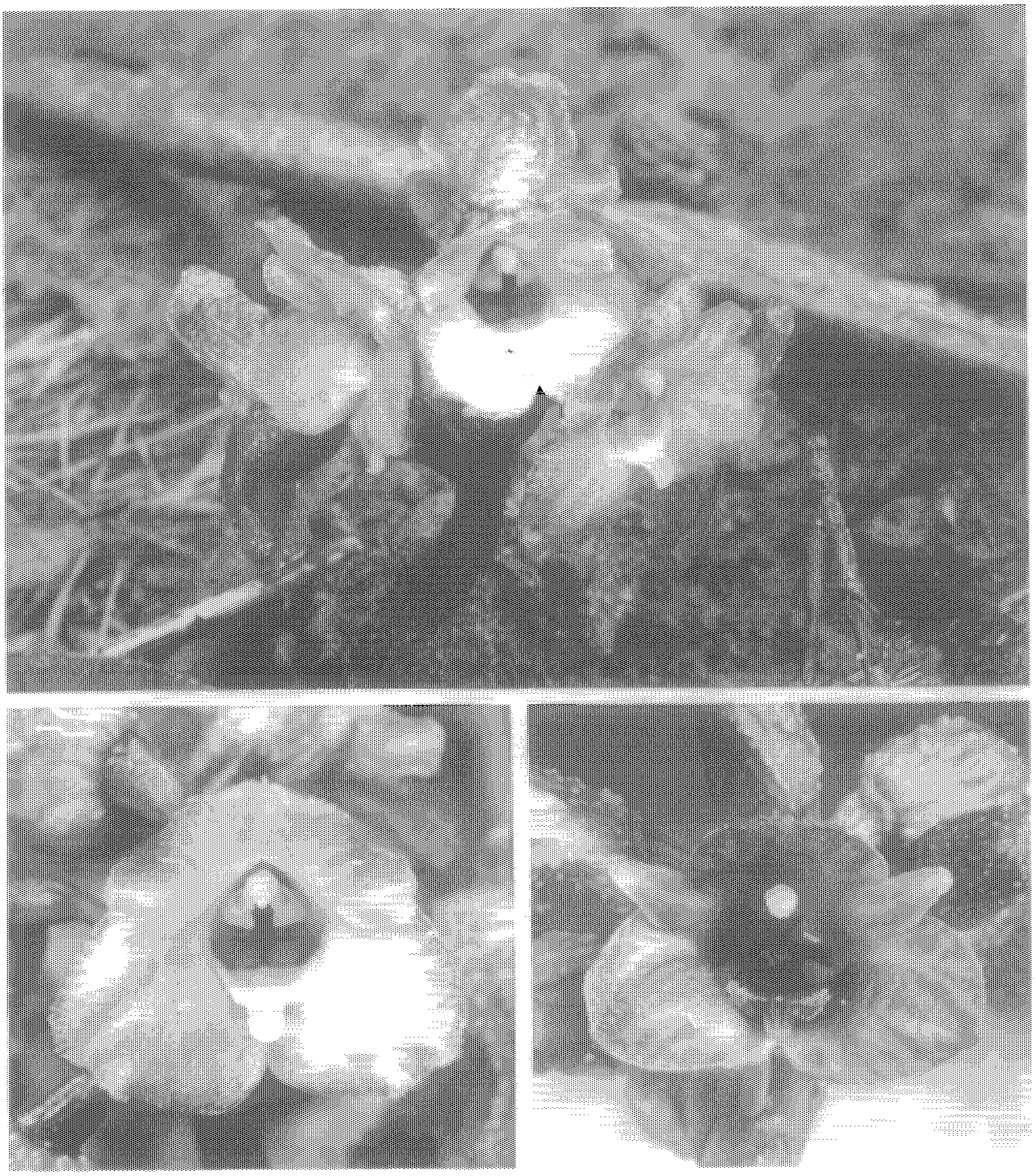

FIG. 2. Flowering plants of unknown *Gastrodia* (rediscovered *G. shimizuana*) and *G. pubilabiata*. Top and bottom left: unknown *Gastrodia* from northern Iriomote Island, Okinawa Pref., Feb. 23, 2000. Bottom right: *G. pubilabiata* from Hirakuchi, Hamakita-shi, Shizuoka Pref., Oct. 8, 2000.

The description for each species is given below.

Unknown *Gastrodia* — Figs. 1-3.

Plant terrestrial, mycoparasitic. **Rhizome** horizontal, cylindrical, sparsely pubescent (hairs to 1 mm long), 4-9 cm long, 6-10 mm across, with deltoid sheaths. **Inflorescence** erect, cylindrical, 4-8 cm long (rachis 0.5-1.5 cm long), with short tubular sheaths. **Bracts** widely ovate to ovate, acute, persistent, 5-8 mm long, 4-6 mm wide. **Pedicel** 6-9 mm long. **Flowers** 1-6, campanulate, 13-14 mm wide. **Sepals** connate into a tube forming an obscure mentum, abaxial surface verrucose, yellowish brown, adaxial surface smooth, light yellowish brown, margins entire or crisped, tubular part 8-9 mm wide. **Dorsal sepal** 8.5-10 mm long, 3-nerved, emarginate; free part widely ovate, spreading, 4.0-7.5 mm long, 5.5-7.3 mm wide. **Lateral**

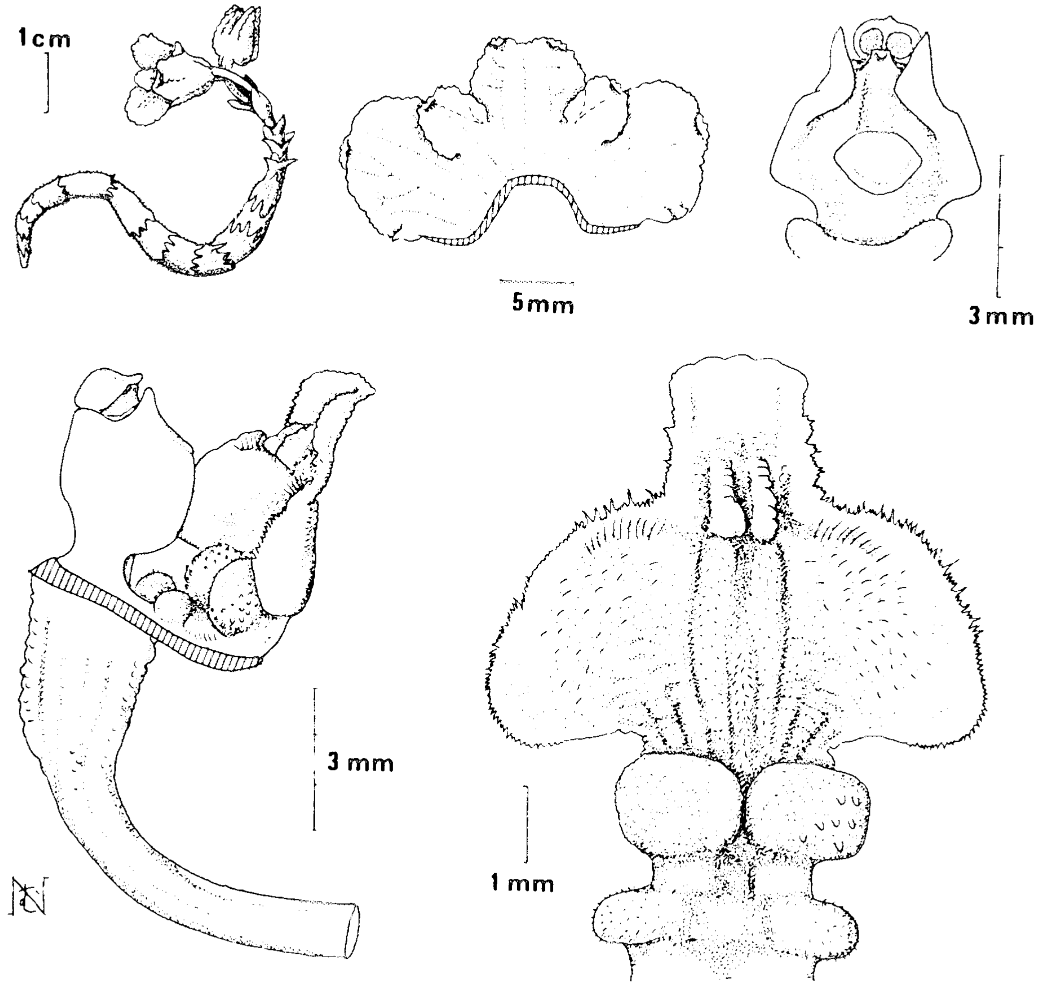

FIG. 3. Unknown *Gastrodia* (rediscovered *G. shimizuana*; *Kobayashi 3679*). Top left: habit. Top middle: perianth tube, dissected and extended. Top right: column, from below. Bottom left: column and lip, side view (perianth tube removed). Bottom right: lip, from above.

sepals 10.5-12.6 mm long, 4-nerved, obtuse; free part widely ovate, spreading, 5.4-8.9 mm long, 6.5-10 mm wide. **Petals** light yellowish brown, adnate to the calyx tube, 1-nerved, margins entire or crisped, surfaces smooth, sometimes verrucose on abaxial side; free part orbicular or widely ovate, obtuse, 3.3-4.6 mm long, 3.5-5.1 mm wide. **Lip** clawed, 3-lobed, 9-nerved, 4.4-5.3 mm long exclusive of claw; claw quadrate or widely obovate, 2.4-2.8 mm wide, adnate to base of sepal tube; lateral lobes semiorbicular or deltoid, 2.8-3.3 mm long, 6.4-7.2 mm wide when expanded, basal 3/4 orange, cream toward apex, adaxial surface pubescent (hairs to 0.2 mm long), with longer hairs (to 0.5 mm long) apically, abaxial surface smooth or papillate, midrib furrowed; midlobe quadrate, glabrous, cream, 1.6-2 mm long, 1.5-1.7 mm wide when expanded; keels 2, deltoid in side view, extending longitudinally from conjunctive part between the midlobe and lateral lobes, highest at base, tapering to apex, 0.4-0.6 mm tall, 0.9-1.2 mm long, 0.5-0.6 mm apart; margins ciliate (hairs to 0.5 mm long), glabrescent basally and apically, sometimes crisped between midlobe and lateral lobes; calli 2, collateral on adaxial side of claw of lip, spherical, green, sparsely papillate (papillae ca. 0.1 mm tall and ca. 0.07 mm across), 1.6-1.8 mm wide. **Column** straight, shorter than lip, 4.2-4.5 mm long inclusive of column foot, 4.1-4.5 mm wide below the middle, greenish; lateral wings truncate, incurved above middle, forming an acute tooth on either side of apex, dilated toward base; stigma borne near middle; anther cap ovoid, 1.4-1.6 mm long, 1.3-1.5 mm wide; transverse ridge between apex of column foot and claw of lip, elevated at both ends, smooth or papillate. **Ovary** obovoid, blackish brown, 4-5 mm long, 2.6-3.7 mm wide. **Capsule** cylindrical, 25-34 mm long; pedicel elongate in fruit, 25-40 cm long. **Seeds** fusiform, 2.5-3 mm long, 0.08-0.14 mm wide.

Gastrodia pubilabiata — Figs. 1, 2.
Plants terrestrial, mycoparasitic. **Rhizome** horizontal, cylindrical, pubescent (hairs to 1 mm long), 4-10 cm long, 6-13 mm across, with deltoid sheaths. **Inflorescence** erect, cylindrical, 3-10 cm long, with short tubular sheaths; rachis 0.5-1 cm long. **Bracts** widely ovate to ovate, acute, persistent, 5-6 mm long, 3-5 mm wide. **Pedicel** 5-10 mm long. **Flowers** 1-6, campanulate, 10-15 mm wide. **Sepals** connate into a tube, forming an obscure mentum, abaxial surface more or less verrucose, adaxial surface smooth, margins entire, tubular part 5-8 mm wide. **Dorsal sepal** 9.1-10.6 mm long, 3-nerved, emarginate, abaxial surface dark purplish brown, adaxial surface pale brown; free part widely ovate, porrect, 5.2-7 mm long, 7.1-8.9 mm wide. **Lateral sepals** 9.2-11.7 mm long, 4-nerved, obtuse, abaxial surface dark purplish brown, adaxial surface dark brown; free part widely ovate, spreading, 5.0-8.3 mm long, 7.0-9 mm wide. **Petals** light brown, adnate to calyx tube, 1-nerved, margins entire, smooth but sometimes verrucose on abaxial side; free part lanceolate, obtuse or acute, 3.7-4.9 mm long, 1.8-2.9 mm wide. **Lip** clawed, 3-lobed, 7-8-nerved, 3.2-4.4 mm long exclusive of claw; claw widely obovate, 2.3-3.2 mm wide, adnate to base of sepal tube; lateral lobes rhombate to widely elliptic or widely ovate, 2.5-3 mm long, 3.8-5 mm wide when expanded, blackish brown, adaxial surface pubescent (hairs to 0.2 mm long), with longer hairs (to 0.5 mm long) apically, abaxial surface smooth or papillate, midrib furrowed; midlobe quadrate, glabrous, blackish brown, 1.1-1.4 mm long, 0.9-1.4 mm wide; keels 2, deltoid in side view, extending longitudinally from conjunctive part between midlobe and lateral lobes, highest at base, tapering to apex, 0.5-0.8 mm tall, 0.9-1.2 mm long, 0.5-0.7 mm apart; margins ciliate (hairs to 0.6 mm long), glabrescent basally and apically, calli 2, collateral on adaxial side of claw of lip, spherical to ellipsoid, dark green, sparsely papillate (papillae ca. 0.1 mm tall, ca. 0.07 mm across), 1.3-1.9 mm wide. **Column** straight, longer than or equaling lip, 4.9-6.3 mm long inclusive of column foot, 3.6-5 mm wide below middle, blackish brown; lateral wings truncate, incurved above middle, forming an acute tooth on either side of apex, dilated toward base; stigma borne near middle; anther cap ovoid, 1.2-1.7 mm long, 1.2-1.6 mm wide; transverse ridge between apex of column foot and claw of lip usually elevated at both ends, smooth. **Ovary** obovoid, dark blackish brown, 3-4 mm long, 2.2-3 mm wide. **Capsule** cylindrical, 22-25 mm long; pedicel elongate in fruit, 15-35 cm long. **Seeds** fusiform, 2.5-3.5 mm long, 0.12-0.2 mm wide.

Discussion

The unknown *Gastrodia* we found on Iriomote Island has three conspicuous characteristics: the pubescent lip, the two deltoid keels on the lip, and the column with wings. Within the *G. verrucosa* group, a lip with two deltoid keels and a winged column are known in *G. pubilabiata*, *G. hiemalis*, and *G. shimizuana*; a pubescent lip is known only from the former two.

Gastrodia pubilabiata is similar to our material in the above characteristics, but differs in the combination of characters summarized in Table 2: degree of openness of the dorsal sepal (Fig. 2), shape of the petals (Fig. 1a), shape of the lip (Fig. 1b), number of nerves on the lip, length of the column relative to the lip (Fig. 1c), color of the perianth lobes and column (Fig. 2) and flowering season.

Gastrodia hiemalis also has a pubescent lip with two deltoid keels (Lin 1987). From the protologue, *G. hiemalis* appears to be more similar to *G. pubilabiata* than to our material because it has dark colored flowers, a porrect dorsal sepal, a rhombate lip, and a column longer than the lip (Table 2). Although the original description of *G. hiemalis* indicates larger sepals and a larger lip than in *G. pubilabiata*, further observations of plants from Taiwan may reveal that they are conspecific.

Of the three species discussed above, *Gastrodia shimizuana* is most similar to our material. The following discussion is based solely on the protologue of *G. shimizuana* by Tuyama (1982), since the type specimen has not been located. *Gastrodia shimizuana* and our material share the following characters (Table 2): spreading sepals, a lip with a semiorbicular or deltoid blade, a column shorter than the lip and flowers in February. One of the populations of our material and the type locality of *G. shimizuana* are within the same river basin. In the protologue of *G. shimizuana*, Tuyama noted the acuminate petals and a subdensely pustular lip. Although these characteristics do not match our unknown plants, the differences are relatively minor and may represent intraspecific variation. We therefore conclude that our material is *G. shimizuana* and represents the first collections of the species since it was described by Tuyama in 1982.

We thank the late T. Tuyama for providing unpublished information and beneficial advice and T. Takaso for providing opportunities for field studies. Thanks are also due to staff members of the herbarium

TABLE 2. Diagnostic characters of *Gastrodia shimizuana* and allied species

	Unknown *Gastrodia* (rediscovered *G. shimizuana*)	*G. pubilabiata*	*G. hiemalis*[1]	*G. shimizuana*[2]
Free part of dorsal sepal	Spreading	Porrect	Porrect, but spreading at tip	Spreading
Free part of petals	Orbicular or widely ovate, obtuse	Lanceolate, obtuse or acute	—	Widely ovate, acuminate
Lip blade	9-nerved, semiorbicular or deltoid	7-8-nerved, rhombate to widely elliptic or widely ovate	Rhombate	9-nerved, deltoid
Column	Shorter than lip	Longer than or equaling lip	Longer than lip	Shorter than lip
Color	Sepals yellowish brown, petals light yellowish brown, lip orange and cream, column greenish	Sepals dark purplish brown, petals light brown, lip and column blackish brown	Flowers dark brown, lip brown	Sepals light brown, lip pale brown, reddish toward apex
Flowering season	Feb. 19-23 [3]	Sept.-Oct. [4]	Dec.	Feb. 15

[1] From the description and illustration by Lin (1987).

[2] From the description and illustration by Tuyama (1982).

[3] First and the last dates when flowers were observed.

[4] Based on our observation and literature (Sawa 1980, Yamashita 1982, Sugino 1983, Hashimoto *et al.* 1991).

of the University Museum, the University of Tokyo (TI) for their help in searching for the type specimen of *G. shimizuana*, Y. Nagata for collecting materials, K. Tagawa for providing locality information, Y. Sawa for useful comments, M. Nakajima for providing unpublished information and for preparing Figure 3, and M. Okada and K. Inoue for their help in surveying the literature.

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